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PHYSICAL CHEMISTRY

The Relationship between Self-Organization and Membrane Effects of Aqueous Dispersion Systems of the Thyroliberin Oligopeptide

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Abstract—The relationship between rearrangement of the dispersed phase inducing considerable changes in the pH and nonmonotonic concentration dependences of membrane effects in aqueous systems of the endogenous regulatory peptide, thyroliberin (thyrotropin-releasing hormone), in 10^{-3}–10^{-16} mol/L concentration range was demonstrated for the first time. The membrane structure modification in the 10^{-13}–10^{-16} mol/L range was found to be due to accumulation of nanoassociates, while the oppositely directed pronounced structural changes in the 10^{-6}–10^{-12} mol/L range may be associated with the coexistence and rearrangement of dispersed phases of various nature (domains and associates) whose action on membrane lipid components is regulated in this concentration range by the correlated changes in the dispersed phase parameters and pH.

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Recently, it has been found experimentally that highly dilute (calculated concentrations of 10^{-6}–10^{-20} mol/L) aqueous solutions of many biologically active compounds (BACs) are actually self-organized dispersion systems, in which nano-sized (100–400 nm) assemblies (nanoassociates) are formed at a definite solute structure and solvent preparation procedure and in the presence of background electromagnetic fields (BEFs). These nanoassociates act as the dispersed phase, the rearrangement of which accounts for the nonmonotonic dependences of the physicochemical properties of these solutions [1, 2]. In view of the established terminology, below these systems are referred to as "dilute solutions," although in reality, they are nanodispersion systems.

A hypothesis interpreting the nonmonotonic bioeffects of BACs in solutions with "ultralow concentrations" from the standpoint of self-organization of dispersion systems has been proposed [1, 2]. The hypothesis implies a correlation between the parameters describing the nanoassociates and the physicochemical and biological properties of aqueous solutions of BACs and is based on the fact that the calculated concentration ranges in which nanoassociates with peak parameters are formed coincide with the concentrations in which the physicochemical characteristics of the systems have peak values and biological activity is most pronounced [1–3].

One more piece of evidence supporting this hypothesis has been obtained using an original procedure for investigation of dilute solutions [2]; the essence of the procedure is comparative study of the self-organization and properties of solutions after they have been kept in either natural or hypoelectromagnetic environment (permalloy container protecting the content from the BEFs). As a rule, at concentrations above the threshold c_{thr}, the ability to form nanoobjects, supramolecular domains several hundred nanometers in size consisting of solute and water molecules, depended little on external fields, whereas below c_{thr}, nanoobjects of the same size range, nanoassociates consisting mainly of water, were formed only in solutions that had been kept under external BEFs, i.e., under ambient conditions. If the hypothesis about the important role of nanoassociates in the generation of bioeffects of highly dilute solutions is valid, then electromagnetically screened solutions (where nanoassociates are not formed or formed in minor amounts) would be either devoid of "abnormal" biological properties [4] or the observed effects would significantly differ from those inherent in solutions kept under ambient conditions.

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